## Claims

What is claimed is:

### Claim 1

The process used for the formation of sealed or open microfluidic channels (3)(16) on a silicon substrate (1)(15). The porous silicon capping layer is planar with the silicon substrate. The process used is a combination of electrochemical dissolution and electropolishing of silicon by using a current density below (for porous silicon formation) or above (for electropolishing) a critical value. The fabrication process is the following: An ohmic contact (26) is first formed on the back side of the said silicon substrate (1)(15), used as anode in the electrochemical dissolution of silicon in order to form locally on silicon the porous silicon layer (2)(17). On the front side of the silicon substrate a masking layer for local porous silicon formation is then deposited and patterned. The porous silicon layer (2)(17) used as capping of the microchannel (3)(16) and the microchannel are formed in one electrochemical step by first using a current density below the critical value for electropolishing, so as porous silicon is formed and by then increasing the current density above the value for electropolishing, so as to form the microchannel by dissolving silicon.

### Claim 2

The fabrication process of a thermal flow sensor based on the process described in claim 1. It comprises the following steps: a) Creation of an ohmic contact (13) on the back side of the said silicon substrate (1), b) deposition and patterning of a masking layer for porous silicon formation in the front side of the silicon substrate, c) porous silicon (2) formation locally on the silicon substrate using electrochemical dissolution of bulk silicon. The current density used in the electrochemical process is below the value of the current density in the electropolishing regime, d) electrochemical dissolution of silicon under the porous silicon layer, using the electropolishing conditions, i.e. a current density above a critical value, so as to form a cavity (3) below a suspended porous silicon membrane (2), e) deposition of a thin dielectric layer for electrical isolation (14), f) deposition and patterning of polycrystalline silicon, which is then doped with p-type dopants, in order to form a heater (4), lying on the porous silicon membrane

and one branch of thermocouples (8), g) deposition and patterning of aluminum or n-doped polycrystalline silicon, in order to form a second branch of thermocouples (9). If the second branch of thermocouples is made of aluminum, during step (g) we also form the interconnections (11) and metal pads (12). If the second branch of thermocouples is made of n-type polysilicon, then there is an extra step of aluminum deposition and patterning, in order to form metal pads and interconnects, h) a passivation layer deposition on top of the gas flow sensor, consisted of an insulating layer, composed either of silicon oxide or silicon nitride or polyimide or other insulator.

**Claim 3**

The fabrication process of a thermal microfluidic sensor based on the process described in claim 1. It comprises the following steps: a) creation of a microfluidic channel (16) sealed with a porous silicon layer (17) on the silicon substrate (15), b) deposition of a thin silicon dioxide layer (25) on top of the whole silicon substrate for electrical isolation, c) deposition and patterning of polycrystalline silicon in order to form a heater resistor (20) and two other resistors (21, 22) on its left and right sides, e) deposition and patterning of aluminum in order to form electrical interconnects (24) and metal pads (23) and f) opening of the inlet (18) and outlet (19) of the microchannel (16) by selectively etching locally the top silicon dioxide layer (25) and the silicon layer (15) underneath. On top of the flow sensor a passivation layer is deposited, consisted of silicon oxide or silicon nitride or polyimide.

**Claim 4**

A thermal flow sensor fabricated with the process described in claim 2. It is consisted of a silicon substrate (1) with a porous silicon membrane (2) fabricated locally on the substrate, on top of a cavity (3). On top of the membrane are integrated a polysilicon resistor (4), used as heater and the so called hot contacts (5) of two series of thermocouples (6,7), each one consisted of p-type polycrystalline silicon (8) and aluminum (9) metal lines or p-type/n-type polycrystalline silicon lines. The second contact of each thermocouple, called cold contact (10), lies on bulk crystalline silicon on the said silicon substrate (1), outside of the said porous silicon membrane (2) area. There are also metal interconnects (11) and aluminum pads (12) on the

said silicon substrate (1), outside the said porous silicon membrane area (2). On the back side of the said silicon substrate (1) there is an ohmic contact (13). A passivation layer may be also deposited on top of the thermal flow sensor, consisted of an insulating layer, for example silicon oxide, or silicon nitride or polyimide. An electrical isolation layer (14) is deposited on top of the silicon substrate (1) so as to assure the electrical isolation between the sensor elements and the substrate. The thermal flow sensor is used as an active device in different sensing systems, as for example in gas flow sensing, in liquid sensing, in flow switches etc.

**Claim 5**

A thermal microfluidic sensor fabricated with the process described in claim 3. It is consisted of a silicon substrate (15) on which a microfluidic channel (16) sealed with a porous silicon layer (17), is formed. The said microfluidic channel has two openings, which serve as inlet (18) and outlet (19) of a fluid. On top of the sealed microfluidic channel there is a polysilicon heater (20) and two polysilicon resistors (21, 22) on each side of the heater. The heater and resistors are connected to aluminum pads (23) through aluminum interconnects (24). On top of the gas flow sensor a passivation layer is deposited, consisted of silicon oxide or silicon nitride or polyimide. The thermal flow device is used to measure the micro-flow developed into the microchannel. The operation of such a microfluidic thermal sensor can be described as follows: The heater is set at a certain temperature; when a flow of a given fluid is present, a temperature difference between the two polysilicon resistors (21, 22) lying on the left and right side of the heater (20), i.e. in the upstream and downstream of the flow, is introduced. This difference is proportional to the flow under determination.

**Claim 6**

The use of the silicon thermal flow sensor described in claim 4, in gas sensing. When gases with different thermal conductivities, exchange heat with the silicon thermal flow sensor, a different signal at the output of each thermopile is induced. This effect is used to distinguish the different gases in the gas flow.

**Claim 7**

The use of the silicon thermal flow sensor described in claim 4, for applications in thermal converters. The sensor measures the true r.m.s. value of an AC signal, regardless of its waveform. This is done by comparing the AC signal with a reference DC signal, which produces the same thermal effect when supplied to the heater lying on the said porous silicon membrane.

**Claim 8**

The use of the silicon thermal flow sensor described in claim 4, as a detector of infrared (IR) radiation. The IR radiation induces a local temperature increase on the sensor, which is measured as a voltage difference at the output of the thermopiles. The output voltage depends on the intensity of the IR radiation.

**Claim 9**

The use of the silicon thermal flow sensor described in claim 4, as a thermoelectric power generator. The thermal power may be provided by the human skin in contact with the sensor, so as to generate heat flow from the skin to the sensor. The operation of the thermoelectric power generator claimed can be described as follows: When there is external heat supply to the power generator, a temperature difference is developed at the output of each thermocouple. The sum of these signals gives the output voltage of the thermoelectric power generator, since the thermocouples are in series.

**Claim 10**

The use of the silicon thermal flow sensor described in claim 4, as a thermoelectric IR power generator. The IR radiation induces a local temperature increase on the sensor, which is transformed to electric power at the output of the sensor. The output power is a function of the intensity of the input IR radiation.